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# The future of energy security of states

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## Abstract

*The work focuses on the controversy about technological progress and unlimited access to all kinds of energy acquisition, storage and distribution. It suggests a formula for energy acquisition and usage which embraces issues of peace and war, social conflicts, and stability determined by access to energy conditioned by the state of the climate of our planet. The question is how will an interdisciplinary combination of progress and future implementation of technologies influence energy security of states and social entities, their natural environment, up to 2030 and beyond? The methods used in the work rely on a non – linear approach to disruptive technologies combined with empirical verifiability of scientific progress in the field of energy acquisition and use. They are reinforced with drivers taken from development scenarios gained through technological development in quantum mechanics, molecular biology, and computational techniques. The result is a conceptual approach to energy acquisition and distribution for states, their communities and individuals regardless of whether the technologies are "civil" or "military" in their essence. The recalled disruptive technologies shape factors of social development and create conditions for human existence and the natural environment that influence the security of states and social entities. The development of automation and robotics, digital transformation, bio-technologies and cognitive science creates new energy security for states, social entities and the natural environment. Technologies for the generation, processing and distribution of energy create an almost unlimited perspective of reconfiguration of existing forms of life and their safety.*

**Keywords:**

energy security, energy acquisition, disruptive technologies, security environment, state security

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*Energy - in physics, the capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear or various other forms. There are, moreover, heat and work - i.e., energy in the process of transfer from one body to another. After it has been transferred, energy is always designated according to its nature. Hence, the transferred heat may become thermal energy and the work done may manifest itself as mechanical energy.*
*Encyclopædia Britannica [Energy]*

## Introduction

The technological revolution, initiated in the 20th century by nuclear fission, DNA sequencing and information technology, has enabled the generation of the next stage of scientific progress. Its character is connected to the transformation of matter, information and life (Agustoni and Maretti, 2012, pp. 391–404). The necessity to obtain and use energy in the fields of bio-surgery, bioinformatics, nanotechnology, the Internet of Things (IoT), regenerative medicine, robotics, 3D printing, cybernetics and artificial intelligence is widespread (van Lier, 2015, pp. 51–61). Technological progress, communication and transport, lifestyle and social development - all these gradually increase the demand for access to energy, regardless of its form or carrier (Goldstein and Qvist, 2019, pp. 43–86). The main issue refers to the energy acquisition, transportation, distribution and final forms of usage based on disruptive technologies (World Energy Scenarios Composing energy futures to 2050, 2013, pp. 12–26). All those forms will shape progress that defines the security of states, social entities and the natural environment (Pinker, 2018, pp. 37–189), and, moreover, security strategies of states and their adaptation to the new coming safety formula as indicated in National Climate Change Plan of the United Arab Emirates 2017-2050.

The result of scientific progress, NBIC technologies - nanotechnology, biotechnology, computer science (big data, the Internet of Things, cognitivism, i.e. artificial intelligence and robotics) - create a new pattern of demand for various sources of energy both for peaceful and combat purposes (Murabit and Bücken, 2019) The range of its use is closely tied to the technologies in which it is or may be used (Mulligan, 2011, pp. 633–649). The old and new needs in the area of energy generation, storage and distribution infrastructure are complemented by the conversion of existing machines and equipment, both fixed and mobile. Not only do they require constant access to energy sources but, in their numbers, they also increase pressure by increasing energy demand (Duffield, 2012, pp. 1–26). In connection with NBIC technologies, this poses challenges to the way in which energy is produced and used in its various forms and also in almost unlimited quantity.
The application of computer technology, telecommunication, biotechnology, environmental engineering, "self" learning machines and devices creates component systems of acquisition, exchange and use of energy (Majumdar, Kumar Banerji, Chakrabarti, 2018, pp. 1247–1255). In addition, it is accessible in increasingly complex and dispersed forms. It concerns every stage of application, acquisition, generation, production, distribution and use of energy in the various regions of the world, on land, in water, in the air, in orbit and in space. Bearing in mind the long-term perspective, on the surface and under the surface of the moon of our planet and on asteroids, it should be stressed that the technical solutions adopted and worked out involve the behaviour of companies, states and organisations. Whole sectors of the economy are being reshaped. Consequently, energy security, which lies behind this concept, is the outcome of many national and international interdependencies and, moreover, is a function of technological progress in different, synergistically interrelated areas of human activity (Gryz, 2018, pp. 33–41).

The article focuses on the controversy about technological progress and unlimited access to all kinds of energy acquisition, storage and distribution that indicate new trends in energy usage which embrace issues of peace and war, social conflicts, and stability determined by access to energy conditioned by the state of the climate of our planet. It is coupled with the development of theories and their interpretation affecting energy security of states and social entities. Not all these technologies are readily available. Their degree of accessibility is very different and could be considered straight-forwardly unrealistic but they play a key role in recognised trends. The trends of energy consumption are used to indicate technological progress and expertise related to unlimited access to all kinds of energy for the purposes of development, regardless of forms of involvement solid hydrogen, super computers, geophysics, or DNA.

The subsequent goals of the article are: definition of a framework for technological progress in shaping energy security, designation of impact of disruptive technologies and progress in energy security. The question is how an interdisciplinary combination of progress and future implementation of technologies will influence energy security of states and social entities and their natural environment, up to 2030 and beyond. The hypothesis stipulates that the disruptive technologies for the generation, processing and distribution of energy combined with the development of automation and robotics, digital transformation, biotechnologies and cognitive science lead to the creation of new needs and the transformation of existing ones in the scope of ensuring energy security of states and societies, individuals and social groups and, what is more, the future development and quality of life in the most developed regions of our planet. At the same time, the ability to use acquisition, storage and distribution of energy may cause conflicts if the appropriate solutions are not adopted in time.

## Methods

Empirical verifiability of scientific progress develops the ability to project it over time. The associated measurable forms of efficiency and optimisation together provide a rational interpretation of understanding. Each element of progress considered separately is only a contribution to determining the place "where we are", combined synergistically with the others in the projection of development "where we will be". Empirical verifiability of scientific progress in the field of energy acquisition and use is always accompanied with the technological progress combined with trends occurring in social affairs. Those two elements mainly encompass a perspective that is based on technological development scenarios, their drivers, and the associated capacity to use energy (Sovacool and Brossmann, 2014, pp. 839–850). All of them together are reflected in political discourse of recent years focused on climate change and limiting the use of "black energy" that comes from fossil fuels and turning it into "green" order (Mulligan, 2011).

The combination of disruptive technologies, trends, development scenarios, empirical verifiability of scientific progress in the field of energy acquisition and use builds a non – linear approach in the work. The base of perception is the drivers from quantum mechanics, molecular biology, and computational techniques (Tvaronavičienė *et al.*, 2015, pp. 502–515). They all involve foresight methodology into the scope of progress in the energy security of states and social entities – i.e. individuals, social groups, societies, states, international communities – into the foreseeable future to 2030 and beyond (Popper, 2008, pp. 44–88). This is reflected upon in successive stages included in the framework and support formula for the technological progress regardless of whether the core of energy technologies is "civil" or "military" (Cooker, 2004, pp. 100–101).

The exploratory assumptions indicate change elements which determine the energy security of states and social entities (Bojanic, 2015, pp. 42–48). In defining the form of energy security, no reference was made to their political, economic, cultural or other non-energy-related issues (Cudworth, 2009, pp. 131–143). No consideration was given to social interactions, the level of technological development in the various regions of the planet, or international cooperation in the field of energy development. The areas related to the fields of political, economic and military cooperation, competition or confrontation between countries with the involvement of transnational corporations in access to energy sources, ways of using them, and projected development have been ignored. It has been assumed that safety is a direct result of development, quality of life, the ability to use technological progress and related expertise to access unlimited kinds of energy acquisition, storage and distribution.

The work covers energy acquisition and distribution, usage methods, technical and technological innovations and progress in the development of the energy sector. This refers to existing technologies as well as those being developed, designed, and based on energy, its extraction, processing, distribution and application (Hidy *et al.*, 2012, pp. 1236–1242). The forms of energy production have been indicated for that reason. A common feature of the discussed issues is the synergistic combination of many areas of knowledge which determine the character of energy security. These considerations are based on the following issues: access to energy, its transmission and use. Likewise, the situation is similar in the case of forms of energy acquisition. The combination both of sources of knowledge, technology and related skills indicates an almost unlimited perspective of knowledge in the field of energy development. Consequently, this results in energy security for individuals and communities, as well as for the state. It is unimportant whether the technologies in their essence are “civil” or “military” - they jointly generate scientific and technical progress according to energy demand of states and organisations (Table 1).

**Table 1. Primary Energy Consumption, Million tonnes oil equivalent (BP Energy Outlook 2035, no date)**

| **Location** | **1995** | **2000** | **2005** | **2010** | **2015** | **2017** | **2020** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **China** | 890.9 | 1,010.9 | 1,803.4 | 2,491.3 | 3,009.8 | 3,132.2 | 3,461.9 | 3,694.2 | 3,839.5 | 3,956.5 | 4,017.2 |
| **EU** | 1,677.7 | 1,748.4 | 1,836.5 | 1,774.7 | 1,649.2 | 1,689.2 | 1,693.9 | 1,650.7 | 1,577.1 | 1,519.8 | 1,474.6 |
| **Non-OECD** | 3,351.2 | 3,744.6 | 5,051.2 | 6,363.5 | 7,430.6 | 7,773.1 | 8,462.1 | 9,399.3 | 10,292.6 | 11,219.0 | 12,146.8 |
| **OECD** | 5,214.0 | 5,611.8 | 5,842.4 | 5,756.0 | 5,629.6 | 5,738.0 | 5,841.6 | 5,864.9 | 5,802.7 | 5,760.9 | 5,719.0 |
| **United States** | 2,070.4 | 2,259.6 | 2,301.3 | 2,235.6 | 2,227.0 | 2,234.9 | 2,278.4 | 2,280.2 | 2,259.6 | 2,238.9 | 2,222.7 |

## Framework for technological progress in shaping energy security

Technological progress in the field of energy acquisition and distribution is coupled with the development of theories and their interpretation; especially the most innovative ones, as well as the older ones, which have the potential to develop new technical solutions and their practical application. Their triple character must be emphasised. This is associated with the methods of energy generation and distribution - network centric, distributed, and mixed. This division, and at the same time the character indicated, relates to the nature of the technology and its application in civil and military ways related to the generation and distribution of energy. It also implicates future use of energy in supply systems.

The first of the mentioned forms - network-centric - creates systemic infrastructure connections between various devices, states and social entities (van Lier, 2015, pp. 51–61). Together they are supported by one or more energy sources. They also create the pos-

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sibility of delivering it to a selected distribution point. In the integrated bands of power channels forming interconnections, it is possible to transmit power to any place, bypassing others, using selected connection lines. The current pover distribution planning in the transmission grid is undertaken through a load profile. This profile is modelled as: (1) one load level; (2) multiple load level; (3) probabilistic; and (4) fuzzy (Georgilakis and Hatziargyriou, 2015, pp. 90–99). The advantage of this solution is uninterrupted access to energy. This type of energy generation and transmission system is constantly being improved, through macro, micro and mini networks. This is particularly the case with energy storage (Pleßmanna *et al.*, 2014, pp. 22–31). In the future, electrolytic processes, periodic or persistent, will be used as a reserve in the event of potential distribution irregularities. Considering the character of existing devices, the methods of installing them are the result of the implementation of technologies developed at the turn of the 1980s and 1990s. Therefore, they are around 25 - 30 years behind the current level of demand for energy storage and accessibility in time. It causes problems referred to as natural environment protection as well as human protection from pollution from fossil fuels.

Current energy consumption is mainly related to energy sourcing and transmission technologies. The progress relies on disruptive technologies using the quantum-mechanical magnetic properties of atoms and it uses variable magnetic fields to direct them; the result is a wireless energy transfer. It should be stressed that energy transmission technologies associated with the use of inductive methods and radio waves are crucial for the charging of machinery and equipment, now and in the future. Thanks to this technology, smartphones and peripherals can be charged remotely. One wave transmitter is enough to power them. A similar technology, based on magnetic resonance, is currently being used to charge electric cars. This means that the charging process is automatic, i.e. wireless, touchless, and remote (Li *et al.*, 2018, pp. 900–901). The chosen method of distribution and, at the same time, energy usage creates almost unlimited, diverse possibilities in the context of machines and devices. They are particularly visible in the field of synthetic biology, and in the perspective of advanced, assisted human biomechanics. In this century, genetic technology will dominate all other technologies, including information technology. Since the fission of the atom, technologies with an equally high impact have not been developed and nuclear energy makes it possible for humanity to be destroyed. New genetic technologies already make it possible to create life where there is no life, to create new inter-species hybrids and not just of one species (Wünderlich *et al.*, 2013, pp. 3–20).

The curvature of the energy beam in quantum form depends on the electro-magnetic pulse and creates the possibility of shaping the energy streams. The issue of the transmission of these streams, the amount of energy contained in them, as well as the distance over which they can be transmitted, is currently the subject of research (Sergentu *et al.*, 2019, pp. 151–157). The Earth's orbit, as a potential source of solar energy, is the goal for obtaining and exploiting this type of energy from solar radiation (Li *et al.*, 2017). The intensity of solar radiation near the equator on a sunny day at noon with a cloud-free sky is about 1,000 watts per m2, while the Earth's orbit is a constant value of 1,368 watts - 27 % more. Considering the location of different places on Earth, the radiation value is significantly lower than the specified 1000 watts (Mankins, 2014, pp. 5–21). It should be stressed that this type of energy supply might have triple this overall value in a network-centric context with networks placed in orbit and on the Earth's surface. Network-centric consists of networks in orbit and on the surface of the Earth. Fixed point transmits energy stored in orbit to the infrastructure on Earth or in its orbit in the case of devices placed on the Earth. Mixed is comprised of networked energy sources in orbit and their routing to a selected energy system on the surface of a planet or in orbit. These three approaches form the basis for future energy generation, storage and distribution activities and the accompanying infrastructure, IT and other solutions is related to both devices and vehicles.

The second form of energy generation and distribution - distributed - is linked to the ways of generating energy through micro and mini grids. This is applicable to the production of electricity and heat from hybrid generation systems (Paska, 2017, pp. 15–37). Moreover, energy storage (e.g. electricity in compressed air in storage tanks and chambers, hydrogen in salt caverns) and its use in the electrolysis processes results in the decomposition of water into oxygen and hydrogen, and the Power-To-Gas installation (P2G) and enables its storage and further use by e.g. mixing with methane and filling gas pipelines (van Lanen *et al.*, 2016, pp. 379–389). Furthermore, it is possible to exploit other physical and chemical phenomena, e.g. related to stored fissile materials, which due to temperature differences can produce energy in a continuous manner. The indicated method therefore includes all forms of energy production, the nature of which is related to its local location. These include engines, turbines and micro gas turbines, Stirling engines, small hydropower plants, wind power plants, solar power plants (thermal and photovoltaic helium), biomass, geothermal energy, and fuel cells. Considering the almost unlimited form of its sources, this form of generation is an important element of energy generation and distribution in significant regions which do not require network centric infrastructure connections. At the same time, it enables an emission-constrained or emission-free economy (Popczyk, 2011).

The third of the forms - mixed - comprises the combined elements of acquiring and distributing the energy from the grid and from the distributed sources. It is associated with limited access to macro, micro and mini infrastructure connections. Its employment is conditional on access to the amount of energy used and its accumulation in order to power it. This form is of importance on the future battlefield, as well as for the supply of infrastructure, equipment and vehicles for this purpose. This applies to weapon systems that have different physical characteristics but require permanent or temporary access to a significant amount of energy in order to activate them. The mixed form guarantees the ability to temporarily store energy in the event of permanent or short-term disruption of availability or its use for specific equipment. The related needs will also allow the use of combined forms of electricity and heat generation using hybrid generation systems (Table 2).

**Table 2. Forms of energy production**

| Form of energy generation | Method of energy transmission | Characteristics | Method of energy production | Energy distribution | Method of energy generation |
|---|---|---|---|---|---|
| Net centric | Cable and wireless transmission: electromagnetic waves, electromagnetic fields | System infrastructure connections<br>transmission lines<br>interconnectors<br>curvature of energy beams | Continuous production<br>Warehousing | Unlimited in space | Macro, micro, mini networks |
| Dispersed | Cable and wireless transmission | Absence of network centric infrastructure connections | Hybrid generation systems<br>Continuous production<br>Temporary<br>Warehousing | Local | Micro and mini networks |
| Mixed | Cable and wireless transmission: electromagnetic waves, electromagnetic fields | Time-limited systems infrastructure connections | Continuous production<br>Warehousing<br>Hybrid generation systems | Restricted in time and space | Macro, micro, mini networks |

With reference to the three forms of energy production and distribution, it should be stressed that they concern energy use at macro, micro and only to a limited extent at mini level. On a macro scale, in the case of power supply to infrastructure, machinery and equipment, civil and military areas (land, sea, air, space and in their combined forms), this scale is determined by the function of space, the amount of energy available in it, the ability to generate and distribute it each time. On the micro scale, similarly to the macro scale, it is used to power machines and devices; and on the mini scale, using nanotechnology, biotechnology, and computer science (NBIC) linked to the energy of individuals, social groups, communities, and societies. The essence of the latter is the connection of individuals and devices, information systems, biological or life support systems and, moreover, creating the possibility for a human to participate in the process as well as creating the possibility for a person or persons to use machines and devices, common databases for acquiring knowledge, skills, sharing and visualising them (Ferry, 2019). The structure of the human body and brain creates almost unlimited possibilities for the use of technology based on energy sources, both internal and external to the body (Wrzosek, 2018, pp. 114–133).

## Disruptive technologies and progress in energy security

Utilisation of energy by people, machines and devices generates and develops this relationship over time. An example of this is the work that has been going on for 80 years to produce metallic hydrogen (Dias and Silvera, 2017, pp. 715–718). This period covers Wigner - Huntington's theory, its verification by R.P. Dias and I.F. Silvera along with the prospect of its application in time. It may lead to making wires out of superconducting metallic hydrogen which may serve to transport energy without any dissipation because it doesn't have resistance (today, in our electrical grid, we lose energy just by heating up the wire during transmission). What is more, it could lead to the creation of superconducting magnetic storage, which maintains persistent currents in superconducting coils. As an outcome, this could be a useful tool for maintaining equilibrium in the power grid when using renewable sources like solar and wind, which produce electricity intermittently. In the interview, Dias speculated that metallic hydrogen could replace the magnets currently used in MRI machines as well levitation of high-speed trains based on the perfect diamagnetism of superconductors. Silvera explained that a metallic state could make hydrogen the most powerful rocket propellant known to man, about four times as powerful as existing rocket propellants that use molecular hydrogen and liquid oxygen (Galeon, 2017)

Energy transformation technologies create a need for in-depth knowledge of such technologies. In this area, the development of computer science is interdependent on the design of works carried out in mechatronics. Creating new and improved editions of super computers is intended to enable a synergy between mechanical engineering, electrical engineering, automation and robotics, regardless of system forms and their related layout. Ultimately, design solutions are also to allow for the creation of an extremely fast quantum computer capable of independently creating algorithms (Riley, 2017). The link between it and the extraction, transmission and distribution of energy, e.g. from the Earth's orbit, is indisputable. This type of computer is designed to be able to work with a set of data sets that are constantly changing, growing and are faster in processing. This research in information technologies is combined with the development of automation and robotics, digital transformation and biotechnological improvement of the human cell genome. For each of them, information related to energy, irrespective of its target form, is necessary.

The projection of the so-called fourth industrial revolution includes devices, machines and vehicles that are able to communicate with each other, cooperate and create and transform reality independently of human beings (Lasi and Kemper, 2014, pp. 239–242). Nowadays, the main focus is on the elements that constitute access to energy and its transformation techniques (Lee *et al.*, 2015, pp. 18–23). There is close linkage between cyber-security and critical energy infrastructure, production, storage, transmission and distribution. *"The holistic architecture of the power system is an architecture in which all the essential power system components are combined into one structure. (...) The overall architecture unites all interactions across the electricity system itself, between network operators, generation and storage operators, consumers and prosumers, and the market, allowing for their harmonization without compromising data privacy or cyber security. It facilitates all the processes that are necessary for the reliable, economical and environmentally friendly operation of intelligent power supply systems"* (White Paper, 2019, pp. 3–6).

The Internet of Things, together with the programming and connectivity of intelligent products, creates infinite possibilities for energy use - from individual products to charging and communication systems (Future Today Institute, 2019). In this respect, the use of "intelligent" materials to collect and communicate information about their state, their design, as well as micro and nano-sensors and transmitters, create another form of energy demand. Multifunctional and composite materials are particularly important for this purpose. Robust and durable, they enable the integration of diagnostic equipment into their structure, the capacity to repair any damage by themselves, and the damping of acoustic waves, and furthermore, the transmission or insulation of heat, the creation of electrical nano-cells, electricity production, and control of the magnetic properties of machine and equipment coatings (Runowski, 2014, pp. 766–775). In addition, the development of automation and robotics, together with the application of artificial intelligence, creates the opportunity to construct intelligent power grids for smart cities, factories, agricultural areas, knowledge societies and prosperity (Rus, 2015). In all of them, the relationship between the human environment and the natural environment is an element of the architecture related to energy security.

The area in which energy is of special importance is the use of a sequence of molecular structure of human genes (Chorąży, 2009, pp. 57–108), both in biotechnology and nanorobotics. A complete human genetic record will enable not only regenerative medicine, but also the previously uncharted biomolecular revolution. In 2012, French microbiologist E. Charpentier and American molecular biologist J. Doudna created a genetic toolkit. Using a set of molecules known as CRISPR-Cas9, the kit allows scientists to make precise, targeted changes to the DNA inside living cells. It is extremely flexible and is far cheaper, quicker and easier to use than previous gene-editing techniques. It can be used to edit not just human DNA, but also that of a wide range of plants and animals opening up the prospect of accelerated advances in medicine (Cartlidge, 2017). Its character is brought to life by discoveries related to materials rich in carbon (fullerenes, carbon nanotubes, graphene).

The synthesis of mechanically bound nanocarbons creates a bridge between carbon nanoscience and molecular machine research. Carbon nanotubes can be metal or semiconductor, depending on the specifics of the atomic connection. As R. Feynman predicts, mechanically coupled molecules are the key structural elements of synthetic machines that operate on a molecular length scale (van Raden and Jasti, 2019, pp. 216–217). Consequently, it will allow for virtual and then real blitzkrieg in the recognition, localisation and precision destruction of genetically weak double helix sequences (helixes) of DNA, their replacement, and the simultaneous removal of molecular layers of viruses and bacteria (and their removal too). This type of application of biochemistry, biomechanics and medicine will allow us to learn about the interactions between genes, proteins, the natural environment, the physical and mental state of individuals, social groups and even - perhaps – societies as R. H. Latiff (2018, pp. 42–51) argues. This appears to be feasible with the use of haplotypes (i.e. series alleles of genes present in the human chromosome), which make it possible to know the origin of an individual and his or her specific species characteristics, above all by determining the individual nucleotide sequences of each of us (Cruciani *et al.*, 2004, pp. 1014–1022).

Artificial intelligence is crucial as the link between nanotechnology, biotechnology, cyberspace and advances in the application of energy to nano and micro devices, energy infrastructure - its functioning, regardless of power supply. However, artificial intelligence still has many limitations so it's worth reviewing them one by one. The concept itself is now deceptive, A.I. signifies a much more advanced technology than the one we currently use. Today, its two main streams, natural language processing and computer vision, are developing at an incredible pace (Mesko, 2017, pp. 239–241). Algorithms running on increasingly powerful computers can now recognise patterns and collect problems. Nevertheless, we are not yet very close to Artificial General Intelligence (AGI) when a machine is able to abstract concepts from limited experience and transfer knowledge between domains (Top Smart Algorithms In Healthcare). The next form is when A.I.'s superintelligence evolves into independent consciousness and will transform modern life by reshaping transportation, health, science, finance, and the military (Grace, 2018, pp. 1–5). This will be an assumption for reshaping the energy security of states and other social entities.

The issue of the emergence of A.I. is related only to the passage of time (Müller and Boström, 2016, pp. 533–571). As a result, the systems of energy generation, distribution for individual and collective needs, institutions, countries and companies, together with the systems of information processing of the social, economic and even cultural phenomena occurring at the same time, will be combined into a single system (Hao, 2019). This will give a shape to all aspects of human existence and the forms of its expression especially in the context of political actions that influence human emotions in relation to elections or lack of them, which are taken under the influence of the communication, regardless of its character (Codevilla, 1989, pp. 78–79). Against this background, the relationship between man's social environment and his natural environment takes on importance. In the case of climate change, the use of energy to transform the natural environment determines the relationship between social expectations and the potential to meet them through access to and use of energy.

For the trends described above in the context of climate change, the latter may prove to be a key factor - especially when geoengineering is considered as a factor for policy makers. NATO's Allied Command Transformation states that today's efforts to reduce the greenhouse effect, based on a reduction of greenhouse gas emissions to "0", would take at least two decades before delivering a tangible impact. This won't happen until after 2035. The warming of the oceans, the reduction in ice around the Arctic, the retreating of glaciers, the raising of the levels of the seas and oceans would continue as they do today. This means that the natural environment will continue to change, and agriculture will transform water supply systems. The associated instability, not necessarily directly, will reinforce the existing tensions in the social, political and economic spheres by compounding the risks (NATO, 2017).

Geoengineering related to the transformation of the atmosphere and the ionosphere is very much implicated in changing conditions in the natural environment and the health of the human species. According to S. Berkley, two thirds of the world's population is expected to be living in urban areas by 2050 - 2.5 billion more than today. Such rapid urbanisation - partly driven by factors such as poverty, conflict and even climate change - will increase the risk of both epidemics and endemic diseases. Higher population densities facilitate infection, while increased pollution and unsanitary conditions can lead to respiratory diseases (such as pneumonia) and diarrheal diseases (such as rotavirus or cholera). He argues that not only poor countries should be concerned. In the coming decades, temperature rises are expected to accelerate the return of disease vectors such as the Aedes aegypti mosquito to parts of Europe and North America and even spread to new regions north to Canada. This could lead to a revival of yellow fever, which was once widespread in the United States and parts of Europe, and to outbreaks of dengue fever and Zika virus. Based on the expertise of the Intergovernmental Panel on Climate Change Data, it is predicted that a combination of climate change and population growth will result in an additional 6 billion people being exposed to dengue fever by 2080 (Berkley, 2019). The prediction of climate and weather changes will lead to an increasing use of climate change technologies. Moreover, the use of the necessary energy and infrastructure, in terms of international security, will involve enabling people to live in areas which are subject to desertification, or in any other way require the use of energy to improve the climate, the environment, plants, animals and people. However, this requires a reassessment of the way in which we think about climate security (Murabit and Bücken, 2019).

M. Kaku (2000, pp. 20–21) argues, before the 22nd century is over, we will lay the foundations of a Type I civilisation and mankind will make its first attempts to reach the nearest stars. This Type I civilisation acquires all forms of energy in their inhabited worlds. They can influence weather, exploit oceans and extract energy from the interior of the planet. Their needs are so great that they must use all available energy resources. Managing energy on such a gigantic scale requires close cooperation between individuals and an effective global communication system. One of the key issues for the future of the relationship between man, energy and time is its impact on climate change on our planet. For example, in 2010, China and India experienced 10 to 15% less sunlight than in 1970 (Ramanathan *et al.*, 2016, pp. 136–141). This relates to the new geological era, Anthropocene in place of the previous Holocene, including the transformation of the natural environment (Waters *et al.*, 2016). At the same time, it reflects the influence of man on the environment enabling the existence of plants, animals and people. The relationship between man, energy and time, and his influence on climate change, triggers two types of energy use - for peaceful ends or conflict and war. In the case of the first type of energy use, its impact on the natural environment through the shaping of weather events should be noted (Chen) Considering the already existing use of technology to induce weather changes, it is necessary to point out the possibility of using it more extensively (Gillian, 2020). One possible way is geoengineering, - intentionally manipulating the earth's climate. It is related to the concepts of the safety of humans and the environment of the planet.

As B. Lomborg suggests, the implementation of any standard policy to reduce the combustion of fossil fuels will take decades, and its effect will only be observable after half a century. Geoengineering can lower global temperatures literally in hours or days. Therefore, only geoengineering, not investments in renewable energy sources, can be an effective insurance policy. He also emphasises that when the Pinatubo volcano erupted in the Philippines in 1991, about 15 million tons of sulfur dioxide were pumped into the stratosphere, which in reaction with water created a misty shroud around the globe. Due to the dispersion and absorption of sunlight, the fog lowered the surface temperature of the Earth for two years. According to his statement, we could imitate this process by introducing aerosols - materials such as sulfur dioxide and soot - the cheapest and least invasive approach is probably what we call the whitening of ocean clouds. It's about splashing droplets of sea water into ocean clouds, making them a little brighter, so they reflect more of the sunlight. This reinforces the natural process by which ocean salt is a condensation molecule for water vapour, creating and strengthening the whiteness of the clouds (Lomborg, 2017). For this second type of energy use, it is important to highlight new types of weapons linked to weather phenomena. They will essentially create a set of tools for achieving political, economic, social and other strategic objectives that are different from existing ones. Moreover, having different characteristics to nuclear weapons, they may become more acceptable in terms of use, both politically and militarily. The applications of energy refer to geophysical weapons using electromagnetic waves of a certain frequency, especially ultra-short and high power. Their orientation at the appropriate layers of the atmosphere allows them to heat and ionise the atmosphere (Gołkowski *et al.*, 2008, pp. 1–12). This enables the generation of atmospheric highs and lows. In addition, it influences the direction of air currents and thus weather phenomena, e.g. heavy rain or drought. These and other similar weather phenomena can be created using magnetic fields and even high-powered lasers. Similar effects can be expected when using energy weapons (Meyl, 2016, pp. 33–34). The impact of such weapons on the human environment will be undeniable. In addition, energy weapons will allow influence to be exercised on social actors, societies and states.

The geophysical weapons work by using sufficiently strong and concentrated ultra-short waves. This causes the deformation of an atmosphere layer which can be raised, bent or even made into something like a giant electromagnetic lens that focuses the sun's rays on specific points. The power of the emission signal is repeatedly amplified by the bombarded media and directed towards the planet's surface as an immensely powerful beam. The use of such electromagnetic weapons can cause all kinds of catastrophes. However, it is difficult to identify their source because the emissive impulse lasts only a short time and is invisible to the naked eye. Cataclysms resulting from a "magnetic shot" would appear to be the result of natural forces (Wiśnicki, 2010). The fact that they can be artificially induced and directed is not yet in the imagination of many people who associate war with a conventional battlefield. On the other hand, it may soon look completely different. Powerful electromagnetic impulses, the source of which are emitters, can not only modify the weather, but also cause the breakdown of everything that has to do with electricity, as well as artificially cause an earthquake of enormous power, destroy selected targets with the use of plasma, and send waves directly to brains (emitters have the ability to send the same waves as the brain), triggering different emotional states. With the use of such transmitters, it is even possible to burn holes in the ionosphere, through which deadly cosmic rays will act on a given area. The state of the ionosphere also affects communication with satellites, including the accuracy of GPS satellite positioning system information (Cooker, 2004, pp. 80–109).

Pointing out the role of energy weapons on the battlefield, it is impossible not to mention the already existing, developed over time - lasers, masers, microwave weapons using electromagnetic radiation, as well as kinetic weapons, e.g. electromagnetic cannons (Wrzosek, 2018, pp. 114–133). These are evidence of a trend to enhance military arsenals of states with new types of weapons, more powerful than ever before. Together with the ones described above, they form an architecture for present and future battlefield weapon systems, encompassing sea, land, air and furthermore space (Harrison *et al.*, 2018, pp. 2–5). The key issue will be how the energy for this theatre will be supplied to individuals, machines and equipment. The future battlefield is to operate based on enhanced soldiers, supported by simulators that give them greater protection, better situational awareness and endurance. They are to operate in mixed groups with omnipresent robots. Automation of decision-making and autonomy of processes in the areas of armament, command and control of teams of individuals, machines and devices will allow for complex operations. Decisions are to be made in real time using concurrently considered options for action and their consequences by, among others, simulating opponent behaviour, modelling the information environment, hacking, disinformation and electronic warfare. This and many other factors will change the perspective of armed conflicts. Undoubtedly, the existing sources of energy generation, processing, distribution and use will be supplemented by other sources that are currently difficult to imagine.

## Conclusions

Unlimited access to energy acquisition combined with almost unlimited usage determines the present trend in the energy security of states and social entities. Despite its sources, it will have implications for the civil and military approach. Considering the current situation, disruptive technologies shape those two factors of social development and create conditions for human existence and the natural environment, especially in the forms of energy production. At the same time, they are prominent in the context of the current projection for the development of societies, especially the most technically advanced ones. From that perspective:

1. Governments need to develop new legal approaches and adopt organisational structures to deal with the trend described. Lack of action in that respect will create power projection and a struggle to adopt disruptive technologies to secure access to energy and its usage. It may cause conflicts on land, in the air, space and water, especially in the context of geoengineering to prevent drought, hurricanes, heavy rain, and earthquakes. The relationship between energy sources, the way in which energy is produced and the environment is crucial for the appraisal of measures taken by states and international organisations.

2. Technological progress and climate change involve the generation of both positive and negative phenomena. Positive - associated with the next generations of machines and devices facilitating human existence. Negative - related to the exploitation for this purpose of the resources of the Earth and its natural environment.

3. The standard model for scoping electromagnetic interactions allows for the creation of subsequent forms of energy related to the phenomenon. New forms of energy and ways of obtaining it are in the imagination of scientists about the transformation of matter, life and information. A sequence of related activities in laboratories all over the world allows us to conclude that the synergy of many theories takes place in interpretations in which energy plays a fundamental role regardless of the formula that is given to it. The sum of these models and their results will influence the projection of energy security of states including individuals, social groups, societies, and their communities. The new forms of energy acquisition and distribution create the transformation of matter, life and information in respect of shaping humankind and its environment.

The Anthropocene, which is characterised by human transformation of the natural environment, is now moving to the next period. Firstly, demand for energy is constantly increasing, especially in the aspect of economy 4.0, and the Internet of things. This relates to new forms of social activities as well as the functioning of social structures. Issues of war and peace, social conflicts, and stability are more and more conditioned by the state of the climate, and the means of power generation which make changes to the climate. They determine the state of thinking about energy security of states and social entities. Secondly, the environment changes under the influence of temperature changes in different parts of the Earth and requires thinking about it in terms of how energy is used. Thirdly, the projection of disruptive technology and the lack or adoption of restrictions in this area by states and the international community undoubtedly indicates the direction. The progress of this trend will become particularly significant for such countries as the United Arab Emirates, China, the United States, the Russian Federation and India, as they are exposed to extreme weather conditions although they have sufficient resources to address the challenges they pose.

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## References

**Agustoni, A. and Maretti, M.** (2012) 'Energy and social change: an introduction', *International Review of Sociology*, 22(3), pp. 391–404. doi: 10.1080/03906701.2012.730820.

**Berkley, S.** (2019) 'Safeguarding Health in a Warming World', *Project Syndicate*. Available at: https://www.project-syndicate.org/commentary/resilience-against-climate-change-disease-risks-by-seth-berkley-2019-07?barrier=accesspaylog (Accessed 6 January 2020).

**Bojanic, D.** (2015) 'Securitisation and macro-securitisation of energy', Security and Defence Quarterly, 6(1), pp.37–62. doi: 10.5604/23008741/1152451.

**BP Energy Outlook 2035** Available at: https://knoema.com/azxrwhd/bp-energy-outlook-2035 (Accessed 5 June 2020).

**Cartlidge, E.** (2017) 'A new genetic revolution', *Technologist*. Available at: https://www.technologist.eu/a-new-genetic-revolution/ (Accessed 18 December 2019).

**Codevilla, A. M.** (1989) 'Political Warfare' in Barnett, F. F. and Carnes, L. (eds) *Political Warfare and Psychological Operations. Rethinking the US Approach*. Washington: National Defense University Press, pp. 78–79.

**Cooker, Ch.** (2004) *The Future of War. The Re-enchantment of War in the Twenty-first Century*. Malden: Blackwell Publishing.

**Cruciani, F., La Fratta, R., Santolamazza, P., Sellitto, D., Pascone, R., Moral, P., Watson, E., Guida, V., Colomb, E. B., Zaharova, B., Lavinha, J., Vona, G., Aman, R., Cali, F., Akar, N., Martin, R., Torroni, A., Novelletto, A., and Scozzari, R.** (2004) 'Report Phylogeographic Analysis of Haplogroup E3b (E-M215) Y Chromosomes Reveals Multiple Migratory Events Within and Out Of Africa', *American Society of Human Genetics*, 74, pp. 1014–1022. doi: 10.1086/386294.

**Cudworth, E.** (2009) 'Nature, Culture, Technology: Myths and Inequalities in the Posthuman Zoo', in Burnett J., Senker P. and Walker K. (eds) *The Myths of Technology: Innovation and Inequality.* New York: Peter Lang Publishing, pp. 131–143.

**Dias, R. P. and Silvera, I. F.** (2017) 'Observation of the Wigner-Huntington transition to metallic hydrogen', *Science* 355(6326), pp. 715–718. doi: 10.1126/science.aal1579.

**Duffield, J. S.** (2012) 'The Return of Energy Insecurity in the Developed Democracies', Contemporary Security Policy, 33(1), pp. 1–26. doi: 10.1080/13523260.2012.659571.

**Energy no date.** Encyclopedia Britannica Available at: https://www.britannica.com/science/energy (Accessed 16 June 2019).

**Ferry, L.** (2019) *Rewolucja transhumanistyczna. Jak technomedycyna i uberyzacja świata zmieniają nasze życie*. Available at: https://wszystkoconajwazniejsze.pl/prof-luc-ferry-rewolucja-transhumanistyczna-jak-technomedycyna-i-uberyzacja-swiata-zmieniaja-nasze-zycie/ (Accessed 12 December 2019).

**Galeon, D.** (2017) 'Scientists Have Finally Created Metallic Hydrogen Scientists just made what could be the rarest and most valuable material on the planet', *Futurism*. Available at: https://futurism.com/scientists-have-finally-created-metallic-hydrogen (Accessed 14 December 2019).

**Gillian, D.** (2020) 'How does cloud-seeding in the UAE work?' *The National UAE*. Available at: https://www.thenational.ae/uae/environment/how-does-cloud-seeding-in-the-uae-work-1.811961 (Accessed 5 January 2020).

**Georgilakis, P. S. and Hatziargyriou, N. D.** (2015) 'A review of power distribution planning in the modern power systems era: Models, methods and future research', *Electric Power Systems Research*, 121, pp. 90–99. doi: 10.1016/j.epsr.2014.12.010.

**Goldstein, J. S. and Qvist, S. A.** (2019) *A bright future: how some countries have solved climate change and the rest can follow*. New York: Public Affairs.

**Gołkowski, M., Inan, U. S., Gibby, A. R., and Cohen, M. B.** (2008) 'Magnetospheric amplification and emission triggering by ELF/VLF waves injected by the 3.6 MW HAARP ionospheric heater', *Journal of Geophysical Research*, 113, pp. 1–12. doi: 10.1029/2008JA013157.

**Grace, K., Salvatier, J., Dafoe, A., Zhang, B., and Evans, O.** (2018) 'When Will AI Exceed Human Performance? Evidence from AI Experts', *Journal of Artificial Intelligence Research*; 1–5.

**Gryz, J.** (2018) *Bezpieczeństwo energetyczne: związki między nauką, polityką a rzeczywistością*. In *Bezpieczeństwo energetyczne. Koncepcje - wyzwania – interesy*; Gryz J., Podraza A., Ruszel M., Eds.; Wydawnictwo PWN: Warszawa, Polska, pp. 33–41.

**Hao, K.** (2019) *Three charts show how China's AI industry is propped up by three companies*, Artificial Intelligence, MIT Technology Review [online]. Available from: https://www.technologyreview.com/s/612813/the-future-of-chinas-ai-industry-is-in-the-hands-of-just-three-companies/ (Assessed 29.12.2019).

**Harrison, T., Johnson, K., Roberts, T. G.** (2018) Space Threat Assessment 2018. Washington: Center for Strategic & International Studies. Available at: https://www.csis.org/analysis/space-threat-assessment-2018 (Accessed: 10 December 2019)

**Hidy, G. M., Chow, J. C., England, G. C., Legge, A. H., Lloyd, A. C. and Watson, J. G.** (2012) 'Energy supplies and future engines for land, sea, and air', *Journal of the Air & Waste Management Association*, 62(11), pp. 1236–1242. doi: 10.1080/10962247.2012.737277.

**Chen, S.** *Could this new Chinese radar system really be used to play God with the weather?* Available at: https://www.scmp.com/news/china/society/article/2148697/could-new-chinese-radar-system-really-be-used-play-god-weather (Accessed 5 January 2020).

**Chorąży, M.** (2009) 'Gen strukturalny – ewolucja pojęcia i dylematy', *Nauka*, 3, pp. 57–108.

**Kaku, M.** (2000) *Wizje Jak nauka zmieni świat w XXI wieku*. Poznań: Prószyński i S-ka.

**van Lanen, D., Walker, S. B., Fowler, M., and Mukherjee, U.** (2016) 'Market mechanisms in power-to-gas systems', *International Journal of Environmental Studies*, 73(3), pp. 379–389. doi: 10.1080/00207233.2016.1165475.

**Lasi, H. and Kemper, H. G.** (2014) 'Industry 4.0', *Business & Information Systems Engineering*, 4, pp. 239–242. doi: 10.1007/s12599-014-0334-4.

**Latiff, R. H.** (2018) *Wojna przyszłości w obliczu nowego globalnego pola bitwy*. Warsaw: Wydawnictwo Naukowe PWN.

**Lee, J., Bagheri, B. and Kao, H. A.** (2015) 'A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems', *Manufacturing Letters* 3, pp. 18–23.

**Li, X., Duan, B., Song, L., Yang, Y., Zhang, Y., and Wang, D.** (2017) 'A new concept of space solar power satellite', *Acta Astronautica*, 136. doi: 10.1016/j.actaastro.2017.03.017.

**Li, Z., Shahidehpour, M., Liu, X.** (2018) 'Cyber-secure decentralized energy management for IoT-enabled active distribution networks', *Journal of Modern Power Systems and Clean Energy*, 6, pp. 900–91. doi: 10.1007/s40565-018-0425-1.

**Lomborg, B.** (2017) 'Geoengineering Climate Change', *Project Syndicate*. Available at: https://www.project-syndicate.org/commentary/geoengineering-climate-change-by-bjorn-lomborg-2017-01?barrier=accesspaylog (Accessed 5 January 2020).

**Majumdar, D., Kumar Banerji, P. and Chakrabarti, S.** (2018) 'Disruptive technology and disruptive innovation: ignore at your peril!' *Technology Analysis & Strategic Management*, 30(11), pp. 1247–1255.

**Mankins, J. C.** (2014) *The Case for Space Solar Power*. Huston: Virginia Edition Publishing.

**Mesko, B.** (2017) 'The role of artificial intelligence in precision medicine', *Expert Review of Precision Medicine and Drug Development*, 5(2), pp. 239–241. doi: 10.1080/23808993.2017.1380516.

**Meyl, K.** (2016) *Der Skalarwellenkrieg Sachbuch mit autobiographischem Bezug*, Villingen-Schwenningen : INDEL GmbH.

**Mulligan, S.** (2011) 'Energy and human ecology: a critical security approach', *Environmental Politics*, 20(5), pp. 633–649.

**Murabit, A. and Bücken, L.** (2019) 'The Myth of Climate Wars?' *Project Syndicate*. Available at: https://www.project-syndicate.org/commentary/climate-security-women-peace-building-by-alaa-murabit-and-luca-bucken-2019-05 (Accessed 6 June 2019).

**Müller, V. C. and Boström, N.** (2016) 'Future Progress in Artificial Intelligence: A Survey of Expert Opinion', in Müller V.C. (ed.) *Fundamental Issues of Artificial Intelligence*. Berlin: Springer International Publishing, pp. 533–571.

**National Climate Change Plan of the United Arab Emirates 2017-2050** (2017) United Arab Emirates Ministry of Climate Change & Environment, pp. 24–41.

**NATO** (2017) Strategic Foresight Analysis. 2017 Report. Available at: https://www.act.nato.int/activities/allied-command-transformations-innovation/understand-and-shape-future (Accessed: 10 December 2019).

**Paska, J.** (2017) *Rozproszone źródła energii*. Warsaw: Oficyna Wydawnicza Politechniki Warszawskiej.

**Pinker, S.** (2018) *Enlighment Now: The Case for Reason, Science, Humanism, and Progress*. New York: Penguin Random House.

**Pleßmanna, G., Erdmannb, M., Hlusiaka, M. and Breyera, Ch.** (2014) 'Global energy storage demand for a 100% renewable electricity supply', *Energy Procedia*, 46, pp. 22 – 31. doi: 10.1016/j.egypro.2014.01.154.

**Popczyk, J.** (2011) *Energetyka rozproszona od dominacji energetyki w gospodarce do zrównoważonego rozwoju, od paliw kopalnych do energii odnawialnej i efektywności energetycznej*. Warsaw: Fundacja Ekonomistów Środowiska i Zasobów Naturalnych. Available at: https://www.cire.pl/pliki/2/e_rozpr_popczyk.pdf (Accessed 5 December 2019).

**Popper, R.** (2008) 'Foresight Methodology', in Georghiou, L., Cassingena Harper, J., Keenan, M., Miles, I. and Popper, R. (eds) *The Handbook of Technology Foresight. Concepts and Practice*, Cheltenham Massachusetts: Edward Elgar Publishing, pp. 44–88.

**Ramanathan, V., Seddon, J., and Victor, D. G.** (2016) 'The Next Front on Climate Change. How to Avoid a Dimmer, Drier World', *Foreign Affairs*, 96(2), pp. 136–141.

**Riley, K.** (2017) 'China Set to Release the World's Fastest Computer. This supercomputer will be 200 times faster than the 2010 world's fastest', *Futurism*. Available at: https://futurism.com/china-set-to-release-the-worlds-fastest-computer (Accessed 14 December 2019).

**Runowski, M.** (2014) 'Nanotechnologia – nanomateriały, nanocząstki i wielofunkcyjne nanostruktury typu rdzeń/powłoka', *Chemik*, 68(9), pp. 766–775.

**Rus, D.** (2015) 'The Robots Are Coming How Technological Breakthroughs Will Transform Everyday Life', *Foreign Affairs*. Available at: https://www.foreignaffairs.com/articles/2015-06-16/robots-are-coming (Accessed 16 December 2019).

**Sergentu, V., Ursaki, V., Ioisher, A., and Eliezer, A.** (2019) 'Solar energy concentrators in geostationary orbits', *Proceedings of the Romanian Academy*, 20, pp. 151–157.

**Sovacool, B.K. and Brossmann, B.** (2014) 'The rhetorical fantasy of energy transitions: implications for energy policy and analysis', *Technology Analysis & Strategic Management*, 26(7), pp. 839–850. doi: 10.1080/09537325.2014.905674.

**Future Today Institute** (2019) *Tech Trends Report 2019. 12th Annual Edition*. Available at: https://futuretoday-institute.com/2019-tech-trends/?platform=hootsuite (Accessed: 10 December 2019)

**Tvaronavičienė, M., Mačiulis, A., Lankauskienė, T., Raudeliūnienė, J., Dzemyda, I.** (2015) 'Energy security and sustainable competitiveness of industry development', *Economic Research-Ekonomska Istraživanja*, 28(1), pp. 502–515. doi: 10.1080/1331677X.2015.1082435.

**van Lier, B.** (2015) 'The enigma of context within network-centric environments', *Cyber-Physical Systems*, 1(1), pp. 51–61. doi: 10.1080/23335777.2015.1036776.

**van Raden, J. M. and Jasti, R.** (2019) 'How to make interlocked nanocarbons Interlocked nanocarbon rings have promising properties for molecular machines', Science, 365 (6450), pp. 216–217. doi: 10.1126/science.aay2861.

**Wünderlich, N., Wangenheim, F., Bitner, M. J.** (2013) 'High Tech and High Touch', *Journal of Service Research*, 16, pp. 3–20. doi: 10.1177/1094670512448413.

**Waters, C. N., Zalasiewicz, J., Summerhayes, C., Barnosky, A. D., Poirier, C., Gałuszka, A., Cearreta, A., Edgeworth, M., Ellis, E. C., Ellis, M., Jeandel, C., Leinfelder, R., McNeill, J. R., Richter, D., Steffen, W., Syvitski, J., Vidas, D., Wagreich, M., Williams, M., Zhisheng, A., Grinevald, J., Odada, E., Oreskes, N., and Wolfe A. P.** (2016) 'The Anthropocene is functionally and stratigraphically distinct from the Holocene', *Science* , 351(6269). doi: 10.1126/science.aad2622.

**White Paper, Holistic architectures for future power systems** (2019) European Technology and Innovation Platform, Smart Networks for Energy Transition, 3-6. Available at: https://www.etip-snet.eu/wp-content/uploads/2019/03/ETIP-SNET_HolisticArchitecture_2019_04_01_Final.pdf (Accessed 17 December 2019).

**Wiśnicki, J.** (2010) 'Broń geofizyczna orężem XXI wieku', *Przegląd Wojsk Lądowych*, 2.

**Wrzosek, M.** (2018) 'Wojny Przyszłości. Doktryna, techniki, operacje militarne', *Fronda*: Warsaw, pp. 114-133.

**World Energy Scenarios Composing energy futures to 2050** (2013) World Energy Council, 12-26 Available at: https://www.worldenergy.org/assets/downloads/World-Energy-Scenarios_Composing-energy-futures-to-2050_Full-report1.pdf (Accessed 17 December 2019).